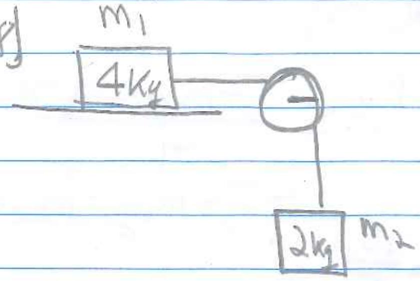
Ch 9 18–19 Hangy Things Rev 68,

*#68)



$r_p = .08\,m$
$m_p = .6\,Kg$

SPEED ∴ Cons of E

$$\cancel{K_{1i}} + \cancel{K_{2i}} + \cancel{U_{1i}} + U_{2i} + \cancel{K_{pi}}^{0} = K_{1f} + K_{2f} + \cancel{U_{1f}} + \cancel{U_{2f}} + K_{pf}$$

$$m_2 g h_i = \frac{1}{2} m_1 V_{1f}^2 + \frac{1}{2} m_2 V_{2f}^2 + \frac{1}{2} I_p \omega^2$$

$V_{1f} = V_{2f} = V_f$

$\omega = \frac{V}{R}$

$I_p = \frac{1}{2} m_p r_p^2$

$$m_2 g h = \frac{1}{2}(m_1 + m_2) V_f^2 + \frac{1}{2}\left(\frac{1}{2} m_p \cancel{r_p^2}\right)\left(\frac{V_f}{\cancel{r_p}}\right)^2$$

$$m_2 g h = \frac{1}{2}(m_1 + m_2) V^2 + \frac{1}{4} m_p V^2$$

$$m_2 g h = V^2\left(\frac{1}{2}(m_1 + m_2) + \frac{1}{4} m_p\right)$$

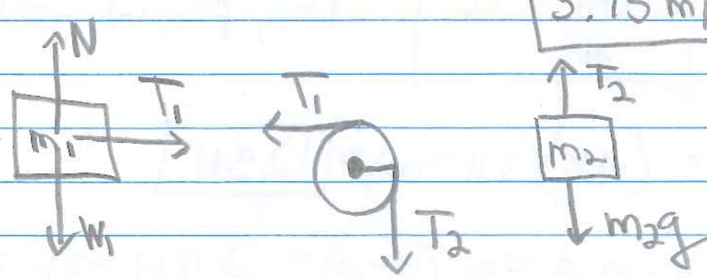
NOTE: $V_p = V_f$
As the pulley turns, all Vs are =

$$\sqrt{\frac{m_2 g h}{\frac{1}{2}(m_1 + m_2) + \frac{1}{4} m_p}} = \sqrt{V^2}$$

$$\sqrt{\frac{(2)(9.81)(2.5)}{\frac{1}{2}(4+2) + \frac{1}{4}(.6)}} = V$$

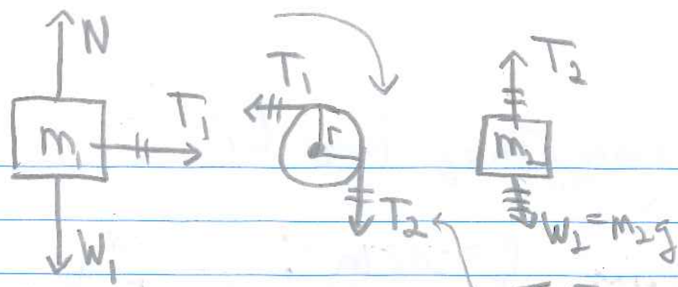
$$\boxed{3.95\,m/s = V}$$

#69)



NOTE: $\Sigma \underline{\underline{F}}_x$ does not include pulley b.c. pulley does not translate.

$\Sigma \tau$ includes both $T_1 + T_2$, in opp directions



ΣF_{x_1}: $T_1 = m a$

$\Sigma F_{y,2}$: $T_2 - m_2 g = -m_2 a$

-1

$-T_2 + m_2 g = m_2 a$

$\Sigma \tau$: $(-T_1 + T_2) r_p = I_p \alpha$

$(-T_1 + T_2) r_p = \frac{1}{2} m_p r_p^2 \cdot \frac{a}{r}$

$(-T_1 + T_2) \cancel{r_p} = \frac{1}{2} m_p \cancel{r_p^2} \cdot \frac{a}{\cancel{r}}$ All r's cxl

$-T_1 + T_2 = \frac{1}{2} m_p a$

Line up, cxl all Ts
$T_1 = -T_2$

$\cancel{T_1} = m_1 a$

$\cancel{-T_2} + m_2 g = m_2 a$

$\cancel{-T_1} + \cancel{T_2} = \frac{1}{2} m_p a$

$m_2 g = m_1 a + m_2 a + \frac{1}{2} m_p a$

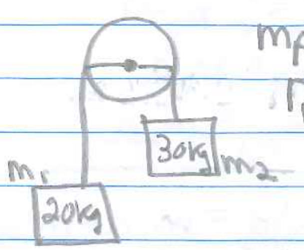
$$\frac{m_2 g}{(m_1 + m_2 + \frac{1}{2} m_p)} = \frac{\cancel{(m_1 + m_2 + \frac{1}{2} m_p)} a}{\cancel{(m_1 + m_2 + \frac{1}{2} m_p)}}$$

$\boxed{3.11 \frac{m}{s^2} = a}$ Now, plug into Eqs for $T_1 + T_2$

$T_1 = m_1 a = (4 kg)(3.11 \, m/s^2) = \boxed{12.5N}$

$T_2 = m_2 g - m_2 a = m_2 (g - a) = 2(9.81 - 3.11) = \boxed{13.4N}$

72) a) SPEED ∴ cons of E



$m_p = 5kg$
$r_p = .1\,m$

$$\cancel{K_{1i}}+\cancel{K_{2i}}+\cancel{U_{1i}}+U_{2i}+\cancel{K_{pi}}^{\,0}=K_{1f}+K_{2f}+U_{1f}+\cancel{U_{2f}}^{\,0}+K_{pf}$$

$$m_2 g h_i = \frac{1}{2}m_1 v_{1f}^2+\frac{1}{2}m_2 v_{2f}^2+m_1 g h_f+\frac{1}{2}I_p\omega_p^2$$

$$m_2 g h_{2i} = \frac{1}{2}m_1 v_{1f}^2+\frac{1}{2}m_2 v_{2f}^2+m_1 g h_f+\frac{1}{2}\left(\frac{1}{2}m_p \cancel{r_p^2}\right)\left(\frac{v_p}{\cancel{r_p}}\right)^2$$

$v_{1f}=v_{2f}=v_{tp}$
$h_{2i}=h_{1f}$

$$m_2 g h = \frac{1}{2}m_1 v_f^2+\frac{1}{2}m_2 v_f^2+m_1 g h+\frac{1}{4}m_p v_f^2$$

$$(m_2-m_1)gh = \left(\frac{1}{2}(m_1+m_2)+\frac{1}{4}m_p\right)v_f^2$$

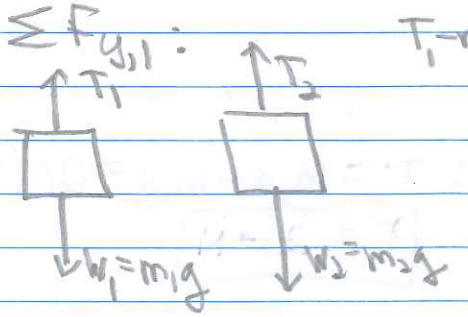
$$\sqrt{\frac{(m_2-m_1)gh}{\left(\frac{1}{2}(m_1+m_2)+\frac{1}{4}m_p\right)}} = \frac{\cancel{\left(\frac{1}{2}(m_1+m_2)+\frac{1}{4}m_p\right)}}{\cancel{\left(\frac{1}{2}(m_1+m_2)+\frac{1}{4}m_p\right)}}\sqrt{v_f^2}$$

$$\sqrt{\frac{(30-20)(9.81)2m}{\frac{1}{2}(30+20)+\frac{1}{4}(5)}} = v_f$$

$$\boxed{2.73\,\frac{m}{s} = v_f}$$

b) $\omega = \frac{v}{r} = \frac{2.73\,m/s}{.1\,m} = \boxed{27.3\text{ rad/sec}}$

c) $\Sigma F_{y,1}$:



$T_1 - m_1 g = m_1 a$ $T_2 - m_2 g = m_2 a$

☆ Two choices here – it's an Atwood, but with a pulley ∴ some a is lost.

$\Sigma F_{y,1}: T_1 - m_1 g = m_1 a$

$\Sigma F_{y,2}: T_2 - m_2 g = m_2 a) \; -1$

$\Sigma \tau: (T_1 - T_2) r_p = I\alpha$

$(T_1 - T_2)\cancel{r_p} = \frac{1}{2} m_p r_p^{\cancel{2}} \cdot \frac{a}{\cancel{r_p}}$

$T_1 - T_2 = \frac{1}{2} m_p a$

c) CHOICE 1:

pulley spin has to agree ∴ $\cancel{-T_1} + \cancel{T_2} = \frac{1}{2} m_p a$

m₂ moves down ∴

$$\cancel{T_1} - m_1 g = m_1 a$$

$$\cancel{-T_2} + m_2 g = m_2 a$$

$$(m_2 - m_1) g = m_1 a + m_2 a + \frac{1}{2} m_p a$$

$$(m_2 - m_1) g = (m_1 + m_2 + \frac{1}{2} m_p) a$$

$$\frac{(m_2 - m_1) g}{m_1 + m_2 + \frac{1}{2} m_p} = a$$

$$\frac{(30-20)9.81}{30+20+\frac{1}{2}(5)} = a$$

for m_1, a is + ; m_2 a is −

$$\boxed{\pm 1.87 \frac{m}{s^2} = a}$$

CHOICE 2: $V_f^2 = \cancel{V_i^2}^{\,0} + 2ad$

$$\frac{V_f^2}{2d} = a$$

$$\frac{(2.73\,m/s)^2}{2(2m)} = a$$

$$\boxed{\pm 1.87 \frac{m}{s^2} = a}$$

Now, use a & subst. into T_1: $T_1 = m_1 a + m_1 g = 20(1.87 + 9.81)$

$$\boxed{T_1 = 234N}$$

& $T_2 = m_2(-a) + m_2 g = 30(-1.87 + 9.81)$

$$\boxed{T_2 = 238N}$$

d) 2 choices: $d_f = \cancel{d_i}^{0} + \cancel{V_i t}^{0} + \frac{1}{2}at^2$

If ~~fall~~, a is neg
If rise, a is pos

$$-2 = \frac{1}{2}(-1.87)t^2$$

$$\frac{-2}{\frac{1}{2}(-1.87)} = t^2$$

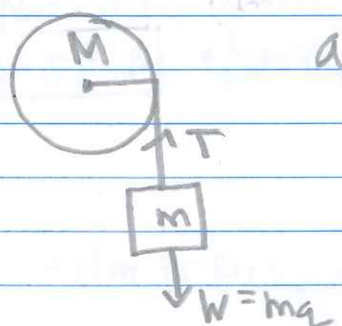
$$\sqrt{2.139} = \sqrt{t^2}$$

$$\boxed{1.46\,s = t}$$

Choice 2: use V_{ave} (since ≠ an acc.)

$$V_{ave} = \frac{d}{t} \therefore t = \frac{d}{V_{ave}} = \frac{2\,m}{\frac{1}{2}(2.73\,m/s)} = \boxed{1.47\,s}$$

#73)



a) $\Sigma F_y: \frac{T - mg}{-1} = \frac{m(a)}{-1}$ $\quad -T + mg = ma$

$\Sigma\tau: TR = I\alpha$

$T\cancel{R} = \frac{2}{5}M\cancel{R^2}\cdot\frac{a}{\cancel{R}}$

$\cancel{T} = \frac{2}{5}Ma$ ma

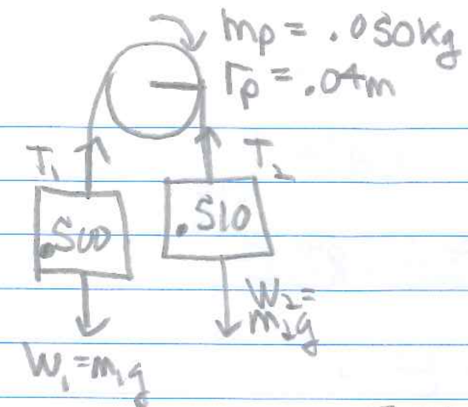
$mg \cancel{-T} = ma$

$mg = \left(\frac{2}{5}M + m\right)a$

$$\boxed{\frac{mg}{\frac{2}{5}M + m}}$$

b) $T = \boxed{mg + m\left(\frac{mg}{\frac{2}{5}M + m}\right)}$

#74)



$\Sigma F_{y,1}: \cancel{T_1} - m_1 g = m_1 a$

$\Sigma F_{y,2}: T_2 - m_2 g = m_2(-a)$ / -1

$-\cancel{T_2} + m_2 g = m_2 a$

$\Sigma \tau: -T_1 + T_2 = \frac{1}{2} m_p a$

pulley has to agree ∴ $(m_2 - m_1)g = (m_1 + m_2 + \frac{1}{2} m_p)a$

$\Sigma \tau: (T_1 - T_2)R = I_p \alpha$

$(T_1 - T_2)R = \frac{1}{2} m_p R_p^2 \cdot \frac{a}{R}$

$$a = \frac{(m_2 - m_1)g}{(m_1 + m_2 + 1/2\, m_p)} = \frac{(.510 - .500)9.81}{(.510 + .500 + \frac{.050}{2})}$$

$$\boxed{a = \pm .0948\ m/s^2}$$

b) $T_1 = m_1(g + a) = .500(9.81 + .0948) = \boxed{4.9524N}$

$T_2 = m_2(g - a) = .510(9.81 - .0948) = \boxed{4.9548N}$

$\Delta T = \boxed{.0024N}$

c) No pulley: $a = \frac{(m_2 - m_1)g}{(m_1 + m_2)} = .0971\ m/s^2$

$T_1 = m_1(g + a) = .500(9.81 + .0971) = \boxed{4.9536N}$

$T_2 = m_2(g - a) = .510(9.81 - .0971) = \boxed{4.9536N}$

correct! T_s should be =